The Bayh-Dole Act may have contributed to the strong rise in academic patenting in the 1980s, although this activity was already increasing before then. However, the act did stimulate the creation of university technology transfer and patenting units and increased attention to commercially relevant technologies and closer ties between research and technological development. A landmark 1980 Supreme Court ruling (*Diamond* v. *Chakrabarty*) allowing patentability of genetically modified life forms may have been a major stimulus behind the recent rapid increases.

University patenting and collaboration with industry in the United States have contributed to the rapid transformation of new and often basic knowledge into industrial innovations, including new products, processes, and services. Other nations, seeing these benefits, are endeavoring to import these and related practices in an effort to strengthen their innovation systems. In the United States, however, the relative success of university-industry collaboration and academic patenting has raised a number of questions about unintended consequences for universities, academic researchers, and academic basic research.

Concerns have been expressed about potential distortions of the nature and direction of academic basic research and about contract clauses specifying delays or limitations in the publication of research results. The possibility exists that research results may be suppressed for commercial gain, deleterious not only to the conduct of research but potentially also to the perception of academia as an impartial seeker of knowledge. Unsettled questions also arise from faculty members' potentially conflicting economic and professional incentives in their relationships with industry or as officers or equity holders in spinoff firms.

The latter issue also arises for universities, which are moving in the direction of acquiring equity in spinoff firms they generate. They also face the question of balancing their support across different fields or concentrating on a few lucrative areas. Scholars are now asking whether academic patenting practices may in fact be undermining the intended goal of enhancing the transfer of new technologies (National Academies STEP 2001).

Conclusion

Strengths and challenges characterize the position of academic R&D in the United States at the beginning of the 21st century. Its graduate education, linked intimately to the conduct of research, is regarded as a model by other countries and attracts large numbers of foreign students, many of whom stay after graduation. Funding of academic R&D continues to expand rapidly, and universities perform nearly half the basic research nationwide. U.S. academic scientists and engineers are collaborating extensively with colleagues in other sectors and increasingly with international colleagues: in 1999, one U.S. journal article in five had at least one international coauthor. Academic patenting and licensing continue to increase, and academic and other scientific and technical articles are increasingly cited on patents, attesting to the usefulness of academic research in producing economic benefits. Academic licensing and option revenues are growing, as are spinoff companies, and universities are increasingly moving into equity positions to maximize their economic returns.

However, there are challenges to be faced and trends that bear watching. The Federal Government's role in funding academic R&D is declining, and fewer institutions receive these funds. Research-performing universities have increased their own funds, which now account for one-fifth of the total. Industry support has grown, but less than might be surmised given the close relationship between R&D and industrial innovation. Industry support barely reached 8 percent of the total in 1999, well below half of universities' own funds. Spending on research equipment as a share of total R&D expenditures declined to 5 percent during the 1990s, a trend worthy of attention.

Academic employment has undergone a long-term shift toward greater use of nonfaculty appointments, both as postdoctorates and in other positions. A researcher pool has grown independent of growth in the faculty ranks. These developments accelerated during the latter half of the 1990s, when both retirements and new hires were beginning to rise. This raises the question of the future development of these related trends during the next decade, when retirements will further accelerate. Another aspect of this issue is the level of foreign participation in the academic enterprise. Academia has been able to attract many talented foreign-born scientists and engineers, and the nation has benefited from their contributions. However, as the percentage of foreign-born degree-holders approaches half the total in some fields, attention shifts to degree-holders who are U.S. citizens. Among those, majority males have been earning a declining number of S&E doctorates, and they also have shown a disinclination to enter academic careers. On the other hand, the number of S&E doctorates earned by U.S. women and members of minority groups has been increasing, and these new Ph.D.-holders have been entering academia. This development will perhaps aid the growing numbers of students from minority backgrounds expected to enroll in college over the next quarter century by providing role models.

Questions arise about the changing nature of academic research and the uses of its results. The number of U.S. articles published in the world's leading journals is declining in absolute numbers, a trend that remains unexplained. This development follows increased funding for academic R&D and coincides with reports from academic researchers that fail to show any large shift in the nature of their research. Regarding protection of intellectual property, universities moving into equity positions raise conflict-of-interest concerns for institutions and researchers that remain unresolved. Public confidence in academia could decline should academia's research or patenting and licensing activities be perceived as violating the public interest.